

## **REMARKS**

Applicants' attorney wishes to thank the Examiner for the courtesy of a telephone interview on October 24, 2003, also attended by co-inventor William J. Gamble. During the interview the meaning of the following terms were compared and contrasted:

“antioxidant” vs. “flame retardant”

“water resistivity” vs. “water vapor transmission”.

An antioxidant is a material incorporated in a substance to enable it to resist degradation due to the effects of oxidation. Antioxidants function to prevent oxidative breakdown of a material and are free radical traps or breakdown inhibitors. The term does not generically include “flame retardants”. “Flame retardants serve to increase the ignition temperature or to promote charring of the material and are only effective under conditions of extreme heat. Although the act of burning is an oxidation reaction with ambient air, the term “antioxidant” is not regarded to include “flame retardation” by those skilled in the art. Similarly, “water resistivity” has to do with the ability of water to degrade a material as by swelling or a hydrolysis reaction mechanism. It does not pertain to the ability of a surface to resist the transmission of water vapor therethrough. Thus, a porous surface may not experience degradation due to the presence of water but could still permit water vapor to pass through the pores. Thus the terms “water resistivity” and “water vapor transmission” are distinct in the art.

The following references are provided as support of these meanings:

Academic Press Dictionary of Science and Technology, Copyright by Academic Press, Inc., 1992, pp. 131, 639, 841, 1062, 1083, 1550, 1668, 2315, and 2355.

Encyclopedia of Chemical Technology, Fourth Edition, Copyright by John Wiley & Sons, Inc., 1991, pp. 424, 258, 976, and 977.

Van Nostrand's Scientific Encyclopedia, Seventh Edition, Copyright by Van Nostrand Reinhold, 1989, p. 1167.

The present amendments serve to limit the claims to an optical device and to the use of the components (a) and (b) in amounts, within specified

ranges, sufficient to improve the resistance of the film in the device to water vapor diffusion. Support may be found in original claims 12 and 14 and pages 5/10 and 7/25.

According to the examiner:

The 35 U.S.C.103(a) rejection of claims 1-21, 25 over Honda et al. in view of Hombek et al. has been repeated for the same reasons previously of record in Paper #2 (mailed 03/17/03).

The 35 U.S.C. 103(a) rejection of claims 22-24 over Honda et al. in view of Hombek et al. and Perregeaux has been repeated for the same reasons previously of record in Paper #2 (mailed 03/17/03).

Both of these rejections are predicated on the combination of Honda and Hombek. The Examiner's basic argument is that there is a reason to combine the teachings of the references and arrive at the invention even if the objective would be other than those of the present invention (reduced water vapor transmission). Applicants disagree.

It is axiomatic that when a combination of references is relied on they must provide a reason for combining them. Honda, US 6,211,358, is directed to films and methods of preparing them. Column 11/31 suggests adding plasticizers for strength or water resistivity, a colorant a UV absorber, or an antioxidant. Honda does not suggest component (b) of the invention nor is the use in an optical element as claimed suggested. The Examiner then turns to Hombek for the disclosure of component (b). However, there is not basis for one skilled in the art to turn to Hombek. Hombeck is not about films of film additives. It is about a triarylphosphate composition such as hydraulic fluids and a process for achieving low air entrainment and not to an optical element or a TAC film containing additives. The materials are not cited for inclusion in a film as plasticizers for strength or water resistivity, a colorant a UV absorber, or an antioxidant. There is no motivation to combine these two references. One relates to a film and additives and the other to a fluid composition to be used under high temperature conditions. Hombek does not suggest any uses in film or with TAC. In particular, there is no suggestion to use component (b) of the invention as "plasticizers for strength or water resistivity, a colorant a UV absorber, or an antioxidant". Thus, there is no motivation to combine these references.

It is settled law that "obvious to try" is not a valid basis for a rejection. *In re Tomlinson et al.*, 363 F2d 928, 150 USPQ 623 (CCPA 1966); *In re Fine*, 5 USPQ 2d 1596 (CAFC 1988). Where the prior art gives no indication of which parameters are critical and no direction as to which of many possible choices is likely to be successful, the fact that the claimed combination falls within the scope of possible combinations taught therein does not render it unpatentably obvious. *In re O'Farrell*, 853 F2d 894, 7 USPQ 1673 (CAFC 1988).

According to the opinion in *In re Sernaker*, 217 USPQ 1 (CAFC 1983), if it is assumed that all the prior art references are related to the same art and therefore known to one of ordinary skill in that art, then the next questions are:

"...(a) whether a combination of the teachings of all or any of the references would have suggested (expressly or by implication) the possibility of achieving further improvement by combining such teachings along the line of the invention in suit, and (b) whether the claimed invention achieved more than a combination which any or all of the prior art references suggested, expressly or by reasonable implication." (Emphasis supplied)

Further, the court concluded:

"...prior art references in combination do not make an invention obvious unless something in the prior art references would suggest the advantage to be derived from combining their teachings." (Emphasis supplied)

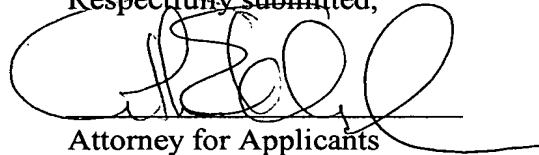
The Examiner "...cannot pick and choose among the individual elements of assorted prior art references to recreate the claimed invention." He "...has the burden to show some teaching or suggestion in the references to support their use in the particular claimed combination." (Emphasis supplied.) *SmithKline Diagnostics Inc V Helena Laboratories Corp.*, 8 USPQ 2d 1468 (CAFC 1988).

Thus, it is not obvious to one of ordinary skill in the art to combine the Honda and Hombek references cited by the Examiner to arrive at an optical product containing the triacetyl cellulose (TAC) film containing the components (a) and (b) in the amounts sufficient to reduce the rate of water vapor transmission.

During the interview, the Examiner inquired about the comparison of the results in Table I. The test employed is an accelerated test in which the layer is subjected to 100% humidity at 100°F for a period long enough for the transmission rate to reach a steady state, about 3-4 days. This steam bath exposure is much more aggressive than most ambient situations. The differences shown under these test conditions would be greatly magnified under normal conditions. This property is extremely important for example in polarizer packages where any diffusion of water vapor will begin to dissolve the water soluble liquid crystal poly vinyl alcohol material comprising the polarizer and render it ineffective. The results of the invention are some 10-15% better than the check and some 3-5% better than the (non-prior art) comparisons tested. This difference in an accelerated test would be far greater in a real life situation.

The Examiner is respectfully requested to enter this amendment since it renders the case allowable or, in the alternative, reduces the number of issues on appeal. The Examiner is respectfully requested to withdraw the outstanding rejection and to pass the subject application to Allowance.

Respectfully submitted,



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Attachments (3):      Academic Press Dictionary of Science and Technology,  
                                 pp. 131, 639, 841, 1062, 1083, 1550, 1668, 2315, and  
                                 2355  
                                 Encyclopedia of Chemical Technology, pp. 424, 258, 976,  
                                 and 977  
                                 Van Nostrand's Scientific Encyclopedia, p. 1167

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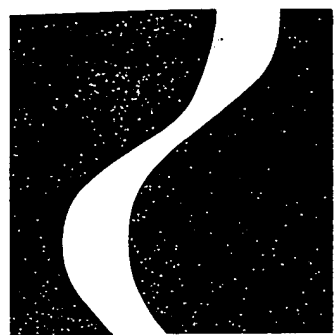
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# Academic Press Dictionary of Science and Technology

Edited by  
Christopher Morris



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- antimony-124** *Nuclear Physics*, a radioactive isotope of antimony with a half-life of 60 days, commonly used as a tracer in solid-state and pipeline flow studies.
- antimony black** *Inorganic Chemistry*, antimony trisulfide occurring in the form of black crystals.
- antimony bromide** see ANTIMONY TRIBROMIDE.
- antimony chloride** see ANTIMONY TRICHLORIDE.
- antimony fluoride** see ANTIMONY TRIFLUORIDE.
- antimony glance** see STIBNITE.
- antimony hydride** *Inorganic Chemistry*,  $\text{SbH}_3$ , a colorless, poisonous gas that boils at  $-17^\circ\text{C}$  and melts at  $-88^\circ\text{C}$ ; slightly soluble in water. Also, STIBINE.
- antimony iodide** see ANTIMONY TRIIODIDE.
- antimonyl** *Chemistry*, the monovalent radical  $\text{SbO}^\cdot$ , which often occurs in formulas of antimony compounds.
- antimonyl potassium tartrate** see TARTAR EMETIC.
- antimony needles** *Inorganic Chemistry*, antimony trisulfide occurring in the form of needles.
- antimony orange** *Inorganic Chemistry*, antimony trisulfide occurring in the form of orange-red crystals.
- antimony oxide** see ANTIMONY TRIOXIDE.
- antimony oxychloride** *Inorganic Chemistry*,  $\text{SbOCl}$ , a white powder that decomposes at  $170^\circ\text{C}$ ; insoluble in water, alcohol, and ether, and soluble in hydrochloric acid; used in flameproofing textiles.
- antimony perchloride** see ANTIMONY PENTACHLORIDE.
- antimony pentachloride** *Inorganic Chemistry*,  $\text{SbCl}_5$ , a reddish yellow oily, hygroscopic liquid, decomposing in excess water; used in analytical testing and in dyeing.
- antimony pentafluoride** *Inorganic Chemistry*,  $\text{SbF}_5$ , a corrosive hygroscopic liquid that reacts violently with water; used in the fluorinating of organic compounds.
- antimony pentasulfide** *Inorganic Chemistry*,  $\text{Sb}_2\text{S}_5$ , an odorless orange-yellow powder, insoluble in water and soluble in alkali and concentrated hydrochloric acid; used as a red pigment. Also, ANTIMONY PERSULFIDE.
- antimony pentoxide** *Inorganic Chemistry*,  $\text{Sb}_2\text{O}_5$ , a white or yellowish powder, insoluble in water; used in the synthesis of antimony compounds.
- antimony persulfide** see ANTIMONY PENTASULFIDE.
- antimony potassium tartrate** see TARTAR EMETIC.
- antimony red** see ANTIMONY PENTASULFIDE.
- antimony sodiate** see SODIUM ANTIMONATE.
- antimony sulfate** see ANTIMONY TRISULFATE.
- antimony sulfide** see ANTIMONY TRISULFIDE.
- antimony tribromide** *Inorganic Chemistry*,  $\text{SbBr}_3$ , a yellow, deliquescent crystalline mass that is decomposed by water; used as a mordant and in manufacturing antimony salts.
- antimony trichloride** *Inorganic Chemistry*,  $\text{SbCl}_3$ , a hygroscopic, colorless crystalline mass, soluble in water; used as a mordant, in fireproofing textiles, and as a chlorinating agent.
- antimony trifluoride** *Inorganic Chemistry*,  $\text{SbF}_3$ , white to gray hygroscopic crystals, soluble in water; used as a fluorinating agent and in dyeing and pottery making.
- antimony triiodide** *Inorganic Chemistry*,  $\text{SbI}_3$ , red crystals, volatile at high temperatures and decomposing in water; insoluble in alcohol and chloroform.
- antimony trioxide** *Inorganic Chemistry*,  $\text{Sb}_2\text{O}_3$ , a white, odorless, crystalline powder, melting at  $655^\circ\text{C}$ ; insoluble in water; used as a powerful reducing agent. Also, antimony (III) oxide.
- antimony trisulfate** *Inorganic Chemistry*,  $\text{Sb}_2(\text{SO}_4)_3$ , a white deliquescent powder, soluble in acids and decomposing in water; used in matches and explosives. Also, ANTIMONY SULFATE.
- antimony trisulfide** *Inorganic Chemistry*,  $\text{Sb}_2\text{S}_3$ , black or orange-red crystals, insoluble in water; used as a pigment and in matches.
- antimony yellow** see LEAD ANTIMONATE.
- antimorph** *Genetics*, a mutant gene that prevents or inhibits the expression of an ancestral or wild phenotype.
- antimutagen** *Genetics*, a compound that interferes with the action of another mutagenic agent or reduces the spontaneous mutation rate.
- antiMüllerian factor or hormone** *Endocrinology*, a glycoprotein that is produced by the embryonic testis and inhibits the development of the Müllerian ducts (precursors of the uterus and fallopian tubes). This factor thus inhibits the development of female phenotype, while the actions of testosterone are required to induce the male phenotype. Also, MÜLLERIAN REGRESSION FACTOR, MÜLLERIAN DUCT INHIBITORY FACTOR.
- antimycin A** *Biochemistry*,  $\text{C}_{22}\text{H}_{40}\text{N}_2\text{O}_9$ , an antibiotic that blocks respiration in the mitochondrial electron transport chain; used as a fungicide, insecticide, and miticide.
- antimycotic** *Medicine*, antifungal; destructive to fungi.
- antineoplastic drug** *Pharmacology*, any agent that inhibits the maturation and proliferation of benign or malignant tumor cells.
- antineuralgic** *Neurology*, counteracting neuralgia; said especially of drugs or therapies.
- antineuritic** *Neurology*, relieving or preventing nerve inflammation.
- antineurotoxin** *Toxicology*, any substance that counteracts the action of a neurotoxin.
- antineutrino** *Particle Physics*, the antiparticle of a neutrino; the particle has zero mass, spin  $1/2$ , and positive helicity.
- antineutron** *Particle Physics*, an uncharged particle of mass equal to that of the neutron but with a magnetic moment in the opposite direction, relative to its spin.
- antinode** *Acoustics*, a point along a sinusoidal standing wave that is halfway between two nodes in the wave; such a point indicates a position of maximum intensity. *Astronomy*, either of two points in an orbit that lie  $90^\circ$  of orbital longitude away from the nodes.
- antinoise** *Acoustics*, a sound that is intentionally generated in order to mask the sound of another noise, by having its wavelength neutralize the wavelength of the unwanted noise. *Acoustical Engineering*, see WHITE NOISE.
- antinoise microphone** *Acoustics*, a microphone, such as a "lip button," that is designed to amplify only the voice or desired sound and to eliminate a high level of surrounding noise.
- antinuclear** *Nuclear Physics*, of or relating to an antinucleus.
- antinuclear antibodies** *Pathology*, antibodies targeting antigens arising in a cell nucleus; serologic measurements indicate antibody levels with the aid of immunofluorescent staining.
- antinucleon** *Particle Physics*, an antineutron or antiproton; i.e., a particle with the same mass as its nucleon counterpart but having opposite charge or opposite magnetic moment.
- antinucleus** *Nuclear Physics*, a type of nucleus that contains antineutrons and antiprotons in the same way that an ordinary nucleus contains neutrons and protons.
- Antioch process** *Metallurgy*, in the production of plaster molds for casting, a process that includes a dehydration step and a rehydration step, yielding a mold that improves the quality of the resulting casting.
- antiodontalgic** *Medicine*, relieving toothache.
- antioncogene** see TUMOR-SUPPRESSOR GENE.
- antioncotic** *Oncology*, a substance that can reduce swelling and inhibit the growth of tumors.
- antioxidant** *Materials Science*, any of various organic compounds that are added to materials such as paints, plastics, gasoline, rubber, and food products in order to reduce the effect of oxidation and the accompanying degradation of properties.
- antiozonant** *Chemistry*, a substance that is added to rubber to inhibit or prevent the severe oxidizing action of ozone on both natural and synthetic elastomers.
- antiparallel** *Molecular Biology*, describing an alignment of two polynucleotide strands that are linked together by base pairing so that the parallel linked strands have opposite polarity, as in native DNA. *Physics*, relating to two vectors that lie along a common line, but point in opposite directions.
- antiparalytic** *Neurology*, counteracting or preventing paralysis; said especially of drugs or therapies.
- antiparasitic agent** *Pharmacology*, a substance that destroys parasites.
- antiparticle** *Particle Physics*, an elementary particle that is identical to another elementary particle in mass and spin but opposite in electric and magnetic properties and that, when brought together with its counterpart, produces mutual annihilation.
- Antipatharia** *Invertebrate Zoology*, an order of black or thorny corals in the class Anthozoa, with a multibranched axial skeleton; found in deep tropical waters.
- antipercolator** *Mechanical Engineering*, in the carburetor of an automotive engine, a valve that vents vapor when the throttle is closed in order to prevent the boiling of fuel into the intake manifold and avoid flooding during restart.
- antipersonnel** *Ordnance*, of a bomb, missile, or other such weapon, intended to kill or injure people rather than to cause damage to structures, vehicles, and installations.
- antipersonnel mine** *Ordnance*, a land mine whose primary purpose is to harm enemy personnel rather than to destroy or disable vehicles.



**diffracted wave** *Physics*, a wave whose propagation direction has been altered by an obstruction, rather than by reflection or refraction.

**diffraction** *Physics*, 1. a phenomenon observed in the propagation of waves in which the propagation direction is changed when a wave encounters an obstruction or edge, such as an aperture. 2. the ability of waves to spread around edges of small dimensions. *Optics*, specifically, the bending of light as it passes an obstruction.

**diffractional** see PULSE-HEIGHT SELECTOR.

**diffraction disk** see AIRY DISC.

**diffraction grating** *Spectroscopy*, a device consisting of a series of fine, closely spaced parallel lines, slits, or grooves scored on glass, metal, or another plane surface, used to disperse light according to wavelength. Also, GRATING.

**diffraction-limited** *Optics*, describing an optical system whose image quality is limited only by diffraction rather than by aberrations or manufacturing errors.

**diffraction loss** *Physics*, the reduction in intensity resulting from diffraction in a wave or beam.

**diffraction pattern** *Physics*, the interference pattern that results when diffracted waves are superposed. *Astronomy*, the image of a star formed by an optically perfect telescope; in a refractor, this consists of a small bright disk surrounded by concentric rings of light; while in a reflector, the disk will have (typically) four spikes caused by diffraction from the secondary mirror supports. *Crystallography*, the experimentally measured values of intensities, diffracting angle (direction), and order of diffraction for each diffracted beam obtained when a crystal is placed in a narrow beam of X-rays or neutrons (usually monochromatic).

**diffraction rings** *Optics*, circular patterns of light that appear to surround particles in the field of a microscope.

**diffraction scattering** *Physics*, the scattering of particles resulting from the removal of particles from a beam by inelastic processes.

**diffraction spectrum** *Spectroscopy*, a spectrum produced by diffraction of light at the grating surface.

**diffraction symmetry** *Crystallography*, the breaking up of light as it passes through a crystal so that the diffraction pattern is the same on either side of the crystal.

**diffraction velocimeter** see LASER VELOCIMETER.

**diffraction zone** *Electromagnetism*, the portion of a radio propagation path that lies outside a line-of-sight path.

**diffractometer** *Physics*, a device used to measure the intensities of diffracted radiation or diffracted neutrons at various angles.

**diffractometry** *Crystallography*, the branch of science that determines the structure of a crystal by observing the changes in amplitude or phase of an X-ray beam or other energy waves penetrating its structure.

**diffuse aurora** *Geophysics*, an auroral form that spreads widely and uniformly across the sky; easily seen in satellite pictures, although not often from the ground.

**diffuse competition** *Ecology*, the simultaneous interspecific competition among several species occupying niches that overlap marginally.

**diffuse-cutting filter** *Optics*, a color filter that modifies its absorption of light rays to coincide with their wavelengths.

**diffused-alloy transistor** see DRIFT TRANSISTOR.

**diffused-base transistor** *Electronics*, a transistor having a nonuniform base region and collector-base junction produced by gaseous diffusion, and an emitter-base junction that is a conventional alloy junction.

**diffused junction** *Electronics*, a diode or transistor junction that is produced by diffusion. Thus, **diffused-junction rectifier**.

**diffused-mesa transistor** *Electronics*, a diffused junction transistor in which alternating layers of P-, N-, and P-type materials are formed in the semiconductor blank by the diffusion and alloying of impurities. After emitter, base, and collector have been formed, unwanted areas are removed by an etching process, leaving a flat-topped, elevated contour.

**diffused metal-oxide semiconductor** *Electronics*, a semiconductor manufactured by a two-stage diffusion of impurities through a single mask opening to give precise-sized narrow channels; used on discrete field-effect transistors for ultrahigh gains and frequency performance.

**diffused resistor** *Electronics*, an integrated-circuit resistor that is produced by diffusion.

**diffuse front** *Meteorology*, a front across which wind shift and temperature change characteristics are not well defined.

**diffuse galactic light** *Astronomy*, starlight reflecting from interstellar dust in the Milky Way.

**diffuse hypergammaglobulinemia** *Medicine*, an increased concentration of immunoglobulins in the plasma, such as that frequently observed in chronic infectious diseases.

**diffuse illumination** *Optics*, illumination in which light emanates from a number of sources and has a high degree of scatter.

**diffuse interface** *Materials Science*, a method of studying dispersivity; an incident light beam is focused on a powdered sample and the resulting scattered light is collected by carefully shaped mirrors and focused on a detector.

**diffuse layer** *Physical Chemistry*, in a double-layer ionic structure, the outer region of ions that are distributed in a cloudlike manner in the electrolytic solution, and that contain an excess or deficiency of ions compared to this solution; as opposed to the rigid inner layer of ions (the compact layer) adsorbed on the surface of the electrode. Also, DIFFUSION LAYER.

**diffuse nebula** *Astronomy*, an irregular gaseous or dusty nebula.

**diffuse placenta** *Developmental Biology*, a placenta in which placental tissue is distributed over the chorionic membrane, as in swine.

**diffuse-porous** *Botany*, of or relating to wood in which the pores (vessels) are of small diameter and those formed early in the growing season have about the same diameter as those formed later; these pores are evenly distributed through the growth ring, as in such trees as the maple and birch.

**diffuser** *Engineering*, a chamber or duct in which a fast-moving low-pressure stream of fluid is transformed into a slow-moving high-pressure stream.

**diffuse radiation** *Physics*, any radiation emanating from a source and traveling in no specified direction.

**diffuse reflection** *Physics*, a reflection from a surface in which the reflected waves have no sharply defined direction, as in reflection off a rough surface. *Optics*, reflection of light rays that is accompanied by scattering, where excess specular reflection does not occur.

**diffuse reflector** *Optics*, a surface that has irregularities larger than the wavelength of the incident radiation, so that the reflected rays are scattered in a number of directions.

**diffuse scattering** *Crystallography*, halos or streaks that appear around intense Bragg reflections in the X-ray diffraction pattern of a crystal; they indicate the presence of disorder in the crystalline structure.

**diffuse series** *Spectroscopy*, for alkali elements, a set of spectral lines that represent a change in total orbital angular momentum accompanying a transition from the *p* state to the *d* state.

**diffuse sound** *Acoustics*, sound that travels in all directions with equal energy distribution and probability, such as an isovelocity area in the ocean.

**diffuse spectrum** *Spectroscopy*, a spectrum having very broad lines although there is no apparent cause for the line broadening.

**diffuse transmission** *Physics*, a passage of waves through a medium in which the transmitted waves propagate in all directions throughout the medium.

**diffuse transmission density** *Optics*, the value of the photographic transmission density, obtained by collecting and measuring the transmitted flux of light that strikes a sample.

**diffusing disk** see DIFFUSION DISK.

**diffusing filter** *Graphic Arts*, a screen used to soften the light on a subject in order to eliminate sharp contrast and detail.

**diffusiometer** *Physics*, a device used for monitoring the diffusion of a substance in a fluid.

**diffusion** a process in which something spreads out or scatters over an area; specific uses include: *Physics*, a process in which particles disperse, moving from regions of higher density to regions of lower density. *Solid-State Physics*, 1. the thermally activated transport of charge carriers through a semiconductor material. 2. the movement of individual atoms through a crystal lattice. *Optics*, 1. the process by which light reflects off an irregular surface in all directions. 2. the process by which light passes through a transparent surface. *Electronics*, a process in the manufacture of semiconductor devices in which impurity materials permeate into precisely controlled areas within a semiconductor substrate to form desired P-N junctions. *Meteorology*, an exchange of fluid parcels between regions in space in apparently random motions on a scale too small to be treated by the equations of motion. *Anthropology*, see CULTURAL DIFFUSION.

**diffusion annealing** *Metallurgy*, a thermal treatment that promotes solid-state diffusion.

**diffusion barrier** *Chemical Engineering*, a porous barrier through which gaseous mixtures pass in order to enrich the lower-molecular-weight constituent of the diffusate; employed as a multiple-stage cascade system for recovering U235F6 isotopes from a U238F6 stream.

**flame polishing** *Materials Science*, a post-machining procedure used on small-diameter rods or filaments; surface and subsurface flaws resulting from machining are removed by rotating the sample and passing it through a flame so that the thin surface layer melts.

**flame propagation** *Chemistry*, the outward spread of a flame into combustible materials.

**flame retardant** *Materials Science*, 1. any chemical compound used to raise the ignition point of such materials as cloth or plastic, and thereby increase their resistance to combustion, 2. see FLAME-RETARDED.

**flame-retarded** *Materials Science*, of a material, treated with chemicals in order to increase its resistance to combustion, such as a material used to make children's pajamas.

**flame spectrometry** *Spectroscopy*, a technique for the measurement of the wavelengths of radiation emitted when a sample is introduced into a flame.

**flame spectrophotometry** *Spectroscopy*, a spectroscopic technique for measuring the intensity of spectral lines in an emission spectrum produced by flame excitation.

**flame spectrum** *Spectroscopy*, an emission spectrum produced by vaporization of a sample in a nonluminous flame.

**flame spraying** *Engineering*, 1. a technique in which powdered fragments of a plastic, along with appropriate fluxes, are projected through a cone of flame onto the surface of an object, 2. a process in which a spray gun feeds wire into a gas flame to install a conductor on a circuit board in molten form; generally the gun has a metal mask or stencil attached. *Metallurgy*, a process of thermal spraying performed by feeding the coating material into a flame.

**flame straightening** *Metallurgy*, the process of improving the shape of a metallic product by local heating with a flame.

**flame structure** *Geology*, a sedimentary structure consisting of mud plumes that have been squeezed upward into an overlying layer at irregular intervals.

**flame test** *Analytical Chemistry*, any qualitative test made with a Bunsen burner, such as a bead test or flame coloration.

**flamethrower or flame thrower** *Ordnance*, a weapon that ignites and projects incendiary fuel. *Engineering*, a similar device designed for non-military use, for example by gardeners to kill weeds or insects.

**flame trap** *Engineering*, a device that keeps a gas flame out of the supply pipe.

**flame treating** *Engineering*, a process of rendering inert thermoplastic objects receptive to inks, lacquers, paints, or adhesives; the object is immersed in an open flame, causing surface oxidation.

**flaming** *Microbiology*, the process of exposing an object, such as a bacteriological loop, to a flame for several seconds to sterilize its surface.

**flamingo** *Vertebrate Zoology*, any of several aquatic birds of the family Phoenicopteridae that have long legs and neck, webbed feet, a broad lamellated bill resembling a duck's but abruptly bent downward, and pinkish plumage.



flamingo

**flammability** [flam'ə bil'ə tē] *Chemistry*, the ease with which a material will become combustible.

**flammability limit** *Chemistry*, either of the limits between which a combustible gas has both enough fuel (lower flammability limit) and enough air (upper flammability limit) to support combustion.

**flammable** [flam'ə bəl] *Materials Science*, of a material, tending to burn; capable of supporting combustion.

**flammable liquid** *Materials Science*, 1. any liquid having a flash point of less than 38°C and a vapor pressure of not over 40 psi at 38°C, 2. any liquid that gives off combustible fumes.

**Flamsteed, John** 1646-1719, English astronomer; first astronomer royal; devised mural arc; compiled first accurate British star catalog.

**Flamsteed number** *Astronomy*, one of a series of sequential numbers assigned by John Flamsteed to naked-eye visible stars in each constellation, beginning at the westernmost star and continuing eastward in order of right ascension.

**flan** *Meteorology*, a term used in Scotland for a sudden gust or squall on land.

**Flanders storm** *Meteorology*, a term used in England for a heavy snowfall with a south wind. (Associated with the region of *Flanders*, on the North Sea opposite southern England.)

**Flandrian transgression** *Oceanography*, the rapid rise of the North Sea at the end of the Wurm glacial stage, between 11,000 and 3000 years ago, when the melting glaciers of Northern Europe caused the water level of the North Sea to rise from 55 meters below its present level to about 6 meters below its present level. (From *Flanders*.)

**flange** [flanj] *Design Engineering*, a rim or collar at the end of a pipe or tube that provides strength or a place to attach something else.

**flanged coupling** *Mechanical Devices*, a shaft coupling composed of two bolted, facing flanges that abut the shaft with a common bolt through them. Also, FACE-PLATE COUPLING.

**flanged pipe** *Mechanical Devices*, a pipe or pipe section with a flange at each end that bolts to an adjoining length of pipe.

**flanged seam** *Mechanical Devices*, a joint made from a furnace tube by flanging and bolting its ends together between a pair of steel rings.

**flange nut** *Mechanical Devices*, a broad-faced nut with a flange attached to the bottom face, used in washerless large-hole coverings.

**flangeway** *Civil Engineering*, an open way through a track or rail structure that furnishes a passageway for the flange of a wheel.

**flanging press** *Mechanical Devices*, a machine that bends the edges of plates to form a flange used to bolt the pieces together. Also, **flanging machine**.

**flank** the side of something; specific uses include: *Vertebrate Zoology*, the fleshy part of an animal or human between the ribs and hip. *Military Science*, 1. the extreme right or left side of a fleet or army, or a subdivision of this, 2. to attack or pass around the flank of the enemy. Thus, **flank guard**, **flank observation**, **flanking attack**. *Geology*, see LIMB. *Building Engineering*, the valley of a roof. *Civil Engineering*, the outer edge of a carriageway. *Mechanical Devices*, either of the inclined surfaces on a screw thread, between the root and the crest.

**flank angle** *Design Engineering*, the angle between the flank of a thread of a screw and a plane perpendicular to the axis when measured from the axial plane of reference.

**flank hole** *Mining Engineering*, 1. a hole bored in advance of a working place, when approaching old workings, 2. a borehole driven from the side of an underground excavation, not parallel with the center line of the excavation, to detect water, gas, or other danger.

**flanking sequence** *Molecular Biology*, the immediate or neighboring upstream or downstream sequence from a designated definitive structure such as a gene.

**flanking window** *Building Engineering*, a window adjacent to an external door.

**flank wall** *Building Engineering*, a side wall.

**flanning** *Building Engineering*, the internal splay of a window, window jamb, fireplace, or doorway from the frame to the inner face of a wall.

**flap** a flat, broad piece that is attached along one side to a larger body; specific uses include: *Aviation*, a moveable, usually hinged airfoil including the trailing edge of an aircraft wing, designed to increase lift or drag by changing the camber of the wing; used to slow an aircraft during landing by increasing lift. *Space Technology*, a vane affixed to a rocket and functioning as a rudder in the air or within the jet stream. *Building Engineering*, a hinge having a plate that is screwed into a door, shutter, or the like. *Surgery*, a mass of tissue that is partially or totally detached from the body for use in grafting. *Graphic Arts*, either of two parts of a book jacket that fold under the front and back covers.

## Hydrology

**Hydrology** literally means the science of water. It has come to denote the study of the properties, distribution, and movement of water on the land surface, in the soil and through the subsurface rocks of the earth. It may be divided into two branches, surface hydrology, which is the science of water on the ground surface, and subsurface hydrology, which is the science of water in the pores and fractures of rocks beneath the ground surface. Subsurface hydrology is also referred to as "geohydrology" or "hydrogeology," with emphasis on the flow characteristics of underground water or the geologic settings of underground water, respectively. Surface hydrology includes limnology (the study of lakes), potamology (the study of surface streams), or cryology (the study of snow and ice).

In addition to the two branches of hydrology there is also the intermediate field of hydrometeorology, which relates the fields of hydrology and meteorology. There is an increasing interest in this subject because of concerns regarding global climatic changes.

Water is essential to almost all human endeavors. Its uneven distribution on the earth both spatially and temporally influences the development of population centers. Accounts of surface water management and well construction for the extraction of ground water are found in the ancient literature, but the science of water was not put on a proper mathematical basis until the early part of this century. Up to 10–20 years ago, hydrology focused mainly on water resource evaluation and management, and water extraction and supply. However, attention is progressively turning towards water quality, because of a heightened concern for surface and ground water contamination and environmental protection. This changing emphasis from water quantity to water quality has stimulated both the basic scientific development of hydrology and the application of hydrology to practical large-scale problems. Significant advances will continue to be made in this exciting field of study, as the demand of water resources of acceptable quality increases with the world's expanding population.

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**hydrology** the scientific study of the portion of the earth that is water, in liquid, frozen, or vapor form, as it moves or is distributed on the earth's surface, under the ground, or in the atmosphere.

**hydrolyase** *Enzymology*, a sub-subclass of enzymes of the lyase class that catalyze the removal of water from a substrate by the breaking of a carbon-oxygen bond, which leads to the formation of a double bond. Also, DEHYDRATASE, HYDRATASE.

**hydrolysis** [hi drāl'ə sis] *Chemistry*, 1. a chemical reaction in which water reacts with another substance and gives decomposition or other products. 2. a reaction of water with a salt to create an acid or base.

**hydrolytic** [hi drā lit'ik] *Chemistry*, characterized by or promoting hydrolysis.

**hydrolytic enzyme** *Enzymology*, an enzyme that acts through hydrolysis, using water to break down a substrate.

**hydrolytic process** *Chemistry*, a double decomposition reaction effected by water, wherein a hydrogen atom goes to one compound and a hydroxyl group to another.

**hydrolyzate** *Geology*, a sediment characterized by elements, such as aluminum, potassium, and sodium, that are easily hydrolyzed and tend to accumulate in the fine-grained alteration products of primary rocks.

**hydromagnesite** *Mineralogy*,  $Mg_3(CO_3)_4(OH)_2 \cdot 4H_2O$ , a colorless or white, transparent, brittle, monoclinic mineral occurring as acicular to bladed crystals and in chalklike form, having a specific gravity of 2.25 and a hardness of 3.5 on the Mohs scale; found as an alteration product of serpentine and related rocks, sometimes in deposits with economic significance.

**hydromechanics** *Fluid Mechanics*, the study and application of fluids, particularly water, as a medium for transmitting forces.

**hydromedusae** *Invertebrate Zoology*, 1. medusae produced as buds from certain hydroids. 2. hydroids.

**hydrometallurgy** *Metallurgy*, the art and science of metal extraction from an aqueous solution.

**hydrometamorphism** *Geology*, the alteration of rock caused by the infiltration of water and the subsequent addition, removal, or exchange of materials in the absence of high temperature or pressure. Also, hydrometasomatism.

**hydromorphic soil** *Agronomy*, a type of soil formed in the presence of excess water.

**hydromyelia** *Neurology*, increased accumulation of spinal fluid, accompanied by dilation of the central canal of the spinal cord. Also, HYDRORACHIS.

**hydronitric acid** see HYDRAZOIC ACID.

**HYDROPAC** *Navigation*, a message, issued by the U.S. Navy Hydrographic Office and broadcast by long-range radio, warning of navigational dangers in the Pacific Ocean. (Formed from *Hydrographic Office* and *Pacific Ocean*.)

**hydropathy** *Medicine*, the use of water in the treatment or cure of disease.

**hydropericardium** *Medicine*, an abnormal accumulation of serous fluid in the pericardial cavity.

**hydropharynx** *Entomology*, a median mouth-part structure anterior to the labium; ducts from the salivary glands open from this structure.

**Hydrophiidae** *Vertebrate Zoology*, a family of sea snakes, having uniform scales and a laterally compressed tail used as a rudder for swimming; found in tropical waters of the Indian and Pacific Oceans.

**hydrophile** *Chemistry*, a hydrophilic substance, usually a colloid or an emulsion.

**hydrophilic** *Chemistry*, having an affinity for water; attracting, dissolving in, or absorbing water.

**Hydrophilidae** *Invertebrate Zoology*, water scavenger beetles, coleopteran insects in the superfamily Hydrophiloidea, mostly plant scavengers.

**Hydrophiloidea** *Invertebrate Zoology*, a superfamily of coleopteran insects, beetles in the suborder Polyphaga.

**hydrophilous** *Biology*, living or thriving in a wet or aquatic environment. Thus, **hydrophile**, **hydrophily**.

**hydrophobe** *Chemistry*, a substance, usually a colloid, that does not adsorb or absorb water. *Biology*, an organism that is intolerant of water or a wet environment.

**hydrophobia** [hi drā fō'hē ə] *Psychology*, an irrational fear of water and other liquids. *Medicine*, another name for rabies; so called because one symptom of the disease is the inability to swallow water. See RABIES.

**hydrophobic** *Chemistry*, relating to or being a hydrophobe; repelling water. *Biology*, not tolerant of water or a wet environment. *Medicine*, of or relating to rabies. *Psychology*, of or relating to hydrophobia.

**hydrophobic bonding** *Molecular Biology*, an attraction between the hydrophobic or nonpolar portions of molecules, causing their aggregation and sequestration away from water molecules.

**hydrophobic effect** *Biochemistry*, the effect of nonpolar groups on lipids, tending to aggregate and exclude water from between them.

**hydrophobicity** *Molecular Biology*, the extent of insolubility, or resistance to wetting or hydration, of a molecule.

**hydrophobophobia** *Psychology*, an irrational fear of rabies.

**hydrophone** *Acoustical Engineering*, an electroacoustic device that converts acoustic energy to electromagnetic waves in a water medium; used to detect and register the source of underwater sounds, as in tracking the presence of a submarine. Also, **hydrophone array**.

**hydrophotometer** *Optics*, an instrument that measures the attenuation coefficient of collimated light passing through a column of sea water.

**Hydrophyllaceae** *Botany*, a family of dicotyledonous herbs and shrubs of the order Solanales, often odorous and characterized by gland-tipped hairs; they are concentrated in dry habitats of the western United States.

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**ignatia** *Toxicology*, the dried ripened seeds of *Strychnos ignatii*, which contain the poisons strychnine and brucine.

**igneous** [ig'nē əs] *Petrology*, of or relating to a rock that was formed by solidification from molten or partly molten material; one of the three principal classifications of rocks, along with metamorphic and sedimentary. (Going back to the Latin word for "fire.")

**igneous complex** *Petrology*, a mass of intimately associated and approximately contemporaneous igneous rocks that differ in form or petrographic type.

**igneous cycle** *Volcanology*, the progress of igneous activity from a volcanic action to large and then smaller intrusions.

**igneous facies** *Petrology*, a part of an igneous rock body that varies in some respect, such as structure, texture, or composition, from the main rock mass.

**igneous meteor** *Geophysics*, any optically visible electric discharge in the atmosphere, such as lightning.

**igneous petrology** *Petrology*, the study of the origin, composition, and occurrence of igneous rocks.

**igneous province** see PETROGRAPHIC PROVINCE.

**ignimbrite** *Petrology*, a pyroclastic volcanic rock deposited from an ash flow; it is commonly silica-rich and may be welded. Also, FLOOD TUFF.

**ignite** *Chemistry*, to cause or begin combustion in a substance.

**igniter** *Engineering*, a blasting charge, fuse, or other device used to fire an explosive charge or to start the combustion of fuel in an engine.

**igniter cord** *Engineering*, a rope that moves an intense flame along at a steady rate, used to ignite safety fuses sequentially.

**igniter pad** *Ordnance*, a thin pad of cartridge cloth containing a black powder charge, used to facilitate ignition in separate loading ammunition.

**igniter train** *Ordnance*, a series of charges that transmits and amplifies the initial fire from the primer to the main charge of an explosive munition. Also, BURNING TRAIN.

**igniting fuse** *Ordnance*, a fuse that sets off the main charge of a munition through ignition rather than through detonation; it is used in munitions with a low explosive charge.

**igniting primer** *Ordnance*, in certain subcaliber gun tubes, a secondary primer that transmits the fire from the primer to the propelling charge.

**ignition** *Chemistry*, 1. the point at which a substance begins combusting. 2. the means by which a combustion process begins. *Mechanical Engineering*, see IGNITION SYSTEM.

**ignition coil** *Electromagnetism*, a small, open-core transformer with a high step-up turn ratio for use in an automotive ignition system.

**ignition interference** *Telecommunications*, a radio interference caused by the spark discharges of a vehicle's ignition system.

**ignition lag** *Mechanical Engineering*, the time interval between the onset of a spark and the resulting pressure rise due to combustion in an engine cylinder. Also, ignition delay.

**ignition quality** *Chemical Engineering*, the characteristic of a fuel represented by the cetane number that causes ignition when the fuel is injected into the compressed air in a diesel engine cylinder.

**ignition system** *Mechanical Engineering*, the system in an internal combustion engine that produces the spark to ignite the mixture of fuel and air; it includes the battery, ignition coil, spark plugs, distributor, and associated switches and wiring. Also, IGNITION.

**ignition temperature** *Chemistry*, the minimum temperature required to begin and maintain combustion of a substance.

**ignitor** *Electronics*, 1. an element that triggers and sustains a discharge in a switching tube. Also, PILOT ELECTRODE. 2. an element in a mercury-pool cathode that causes conduction at a given point in an alternating-current cycle.

**ignitron** *Electronics*, a mercury-pool rectifier in which a high concentration of electrons, known as a cathode spot, appears on the pool surface before conduction begins.

**ignitron contactor** *Electronics*, a device that serves as a heavy duty switch in a resistance-welding transformer.

**ignorable coordinate** *Mechanics*, a term for a generalized coordinate that does not appear explicitly in the Lagrangian expression for the kinetic and potential energy of a conservative holonomic dynamical system.

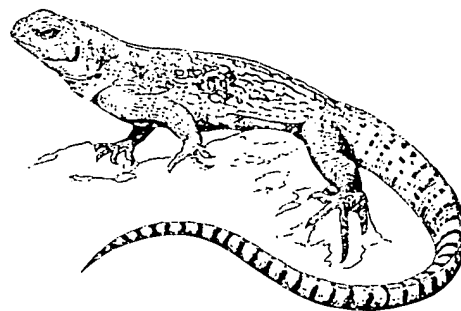
**ignore character** *Computer Programming*, a character indicating that no action is to be performed, or an instruction requiring that normal execution of a command not occur.

**IGT** impaired glucose tolerance.

**IGT or I.G.T.** Institute of Gas Technology

**IGU or I.G.U.** International Geographical Union.

**iguana** [i gwān'ə] *Vertebrate Zoology*, a large neotropical American lizard belonging to the family Iguanidae that is insectivorous and is typically dark-colored with a serrated dorsal crest.



iguana

**Iguanidae** *Vertebrate Zoology*, a large family of arboreal lizards of the order Squamata, containing over 600 diverse, predominantly American species.

**Iguanodon** *Paleontology*, a genus of bipedal ornithischian dinosaurs in the suborder Ornithopoda and family Iguanodontidae; one of the largest animals of the Lower Cretaceous, ranging from 6 to 11 meters long.

**IGY or I.G.Y.** International Geophysical Year.

**I.H.** infectious hepatitis.

**IHD** ischemic heart disease.

**IHD or I.H.D.** International Hydrological Decade.

**I-head cylinder** *Mechanical Engineering*, an internal-combustion engine design characterized by the placement of both inlet and exhaust valves in the cylinder head.

**IHP** indicated horsepower.

**ILL** integrated injection logic.

**ijolite** *Petrology*, an alkaline plutonic rock or rock group with a granitic texture, consisting of nepheline and mafic minerals, generally including sodic pyroxene, and commonly containing accessory apatite, calcite, sphene, and melanite.

**Ikara** *Ordnance*, an Australian long-range, antisubmarine missile powered by a dual-thrust, solid-propellant rocket motor; it is equipped with radio/radar guidance and carries a lightweight acoustical homing torpedo that is lowered into the water by parachute.

**Ikeya-Seki** *Astronomy*, comet 1965 VIII, a bright sun-grazing comet that was visible in daylight during October 1965, and which displayed a tail 60° long at maximum; its nucleus split into three parts at perihelion.

**IL** interleukin.

**Il** the chemical symbol for illinium.

**IL** integrated injection logic.

**il-** a prefix meaning: 1. in or into, as in *illuminate*. 2. not, as in *illegible*.

**ILA** International Laboratory Accreditation Cooperation.

**I.L.A.** International Leprosy Association.

**ilang-ilang oil** *Materials*, an oil derived from the blossoms of the tree *Canarium odorata*; used in perfumery. Also, YLANG-YLANG OIL.

**ilarvirus** *Plant Pathology*, a virus that causes the prunus necrotic ringspot virus and is transmitted through the sap or seeds of the plant.

**Ilarvirus group** *Virology*, a group of tripartite ssRNA-containing plant viruses with quasi-isometric particles; transmitted mechanically and through seeds and pollen over a wide host range. Also, ISOMETRIC LABILE RINGSPOT VIRUSES, TOBACCO STREAK VIRUS GROUP.

**ileac** *Medicine*, relating to or affecting the ileum.

**ileitis** *Medicine*, an inflammation of the ileum.

**ileocecal** *Anatomy*, relating to the ileum and the cecum.

**ileocecal valve** *Anatomy*, the sphincter located where the ileum of the small intestine empties into the cecum of the large intestine.

**ileocecostomy** see CECOILEOSTOMY.

**ileocolic artery** *Anatomy*, a branch of the superior mesenteric artery that supplies blood to the terminal portion of the ileum, cecum, appendix, and ascending colon.

**ileocolic intussusception** *Medicine*, infolding of the ileum through the ileocecal valve into the colon. Also, **ileocolic introsusception**.

**ileocolitis** *Medicine*, inflammation of both the ileum and colon.

**ileocolostomy** *Surgery*, the surgical creation of an opening between the ileum and the colon.

**Oxalidaceae** *Botany*, a diverse family of dicotyledonous trees, shrubs, and tuberous and bulbous herbs in the order Geraniales, characterized by regular, perfect flowers, seeds that have a basal aril, and capsular fruit.



Oxalidaceae

**oxalite** *see* HUMBOLDTINE.

**oxaloacetate** *Biochemistry*, a metabolic intermediate, formed from aspartic acid by transamination, that couples with acetyl-CoA to form citrate.

**oxalosis** *Medicine*, a rare autosomal recessive metabolic error resulting in impaired glyoxylic acid metabolism, characterized by renal calculi, nephrocalcinosis, and renal insufficiency.

**oxaluria** *Medicine*, the excretion of an abnormally large amount of oxalates in the urine.

**oxamide** *Organic Chemistry*,  $\text{NH}_2\text{COCONH}_2$ , a white, odorless powder slightly soluble in water that melts at  $419^\circ\text{C}$ ; used as a possible substitute for urea in fertilizers.

**oxamite** *Mineralogy*,  $(\text{NH}_4)_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$ , a yellowish-white to colorless orthorhombic mineral occurring as lamellar pulverulent masses, and having a specific gravity of about 1.5 and a hardness of 2.5 on the Mohs scale; found in guano deposits on the Guanape Islands, Peru.

**oxammonium** *see* HYDROXYLAMINE.

**oxamyl** *Organic Chemistry*,  $\text{C}_7\text{H}_{13}\text{N}_3\text{O}_3\text{S}$ , a white crystalline solid; melts at  $100\text{--}102^\circ\text{C}$ ; used as an insecticide.

**oxazine** *Organic Chemistry*, any of several compounds used as dyes having the formula  $\text{C}_4\text{H}_3\text{NO}$ , and consisting of a ring containing four carbons, one oxygen, and one nitrogen.

**oxazole** *Organic Chemistry*,  $\text{C}_3\text{H}_3\text{NO}$ , a liquid that boils at  $69^\circ\text{C}$ ; a five-membered heterocyclic compound used in organic synthesis.

**oxbow** *Agriculture*, a U-shaped piece of wood formerly used as part of an ox yoke. *Hydrology*, 1. a looping stream meander having such an extreme bend that only a neck of land is left between the two parts of the stream. Also, OXBOW STREAM, HORSESHOE BEND. 2. *see* OXBOW LAKE. *Geology*, 1. the horseshoe-shaped abandoned channel of a former oxbow stream, left when it cuts a new channel across the narrow meander neck. Also, ABANDONED CHANNEL. 2. in New England, land completely or partially enclosed within a bend of a stream.

**oxbow lake** *Hydrology*, a crescent-shaped lake formed when a stream cuts a new channel across the narrow neck of an oxbow, which later becomes separated from the new main stream by the deposition of silt. Also, OXBOW, HORSESHOE LAKE, MOAT, LOOP LAKE.

**oxbow stream** *Hydrology*, *see* OXBOW, def. 1.

**Oxford** *Agriculture*, a breed of mutton and medium wool sheep having a gray nose and ears, and no horns. (From Oxford, England, where the breed was developed.)

**Oxfordian** *Geology*, a European geologic stage of the Upper Jurassic period, occurring after the Callovian and before the Kimmeridgian. Also, DIVESIAN.

**oxic** *Ecology*, describing a soil layer from which most of the silica has been leached.

**oxidant** *see* OXIDIZER.

**oxidase** *Enzymology*, an enzyme of the oxidoreductase class that catalyzes the oxidation of a substrate with oxygen acting as the electron acceptor.

**oxidase test** *Bacteriology*, an assay used to identify aerobic bacteria by testing the ability of a given strain to transform certain amines into colored products.

**oxidate** *Geology*, a sediment composed of oxides and hydroxides of iron and manganese, crystallized from aqueous solution.

**oxidation** *Chemistry*, any reaction in which one or more electrons are removed from a species, thus increasing its valence (oxidation state); oxidation always occurs simultaneously with reduction, in which another species gains the electrons lost from the oxidized species. In an electrochemical cell, oxidation occurs at the anode. *Materials Science*, the deposit that forms on the surface of a metal as it oxidizes.

**oxidation-fermentation test** *Microbiology*, an assay that is used to determine whether a given bacterial strain carries out an oxidative or a fermentative mode of metabolism (or none at all) on a particular carbohydrate substrate.

**oxidation number** *Chemistry*, the number of electrons needed to restore an atom in a combined state to its elemental form.

**oxidation pond** *Civil Engineering*, a pond that holds partially treated waste water to allow algae, aquatic plants and microorganisms to decompose the organic waste.

**oxidation potential** *Physical Chemistry*, 1. the difference in the amount of energy contained in an atom or an ion and the amount of energy remaining once an electron leaves its orbit. 2. the energy that can be generated by an electrode when all the substances involved in the electrolytic process are in their standard states.

**oxidation-reduction indicator** *Analytical Chemistry*, a compound that changes color when it loses or gains electrons.

**oxidation-reduction reaction** *Chemistry*, any chemical change in which one species is oxidized (loses electrons) and another species is reduced (gains electrons).

**oxidation state** *Chemistry*, the condition of an atom as expressed by its oxidation number.

**oxidative aging** *Materials Science*, the aging of elastomers or other polymers in the presence of oxygen, primarily causing an increase in brittleness.

**oxidative phosphorylation** *Biochemistry*, the phosphorylation of ADP to ATP, or the creation of a pyrophosphate from an inorganic phosphate during a chemical reaction driven by a proton motive force powered by a respiratory chain.

**oxide** *Chemistry*, any binary compound of oxygen, especially with a metal.

**oxide-coated cathode** *Electronics*, a cathode or filament that has been coated with oxides of alkaline-earth metals, such as thorium oxide, to increase electron emission at low temperatures.

**oxide dispersion strengthening** *Materials Science*, a process of strengthening an alloy through internal oxidation, in which one of the components is oxidized within the matrix.

**oxide-induced crack closure** *Materials Science*, the effect of oxides within cracks to close them, decreasing crack growth or propagation.

**oxide isolation** *Electronics*, a method for isolating elements in an integrated circuit by inserting a layer of silicon oxide around each element.

**oxide mineral** *Mineralogy*, a mineral formed by the combination of one or more metallic elements with oxygen; for example, corundum, hematite, and spinel.

**oxide nuclear fuel** *Nuclear*, fissionable nuclear fuel of the form  $\text{UO}_2$  or  $\text{PuO}_2$ .

**oxide passivation** *Electronics*, a method for achieving stability in an integrated circuit by covering the surface with a layer of insulating oxide.

**oxidite** *see* SHALE BALL.

**oxidize** *Chemistry*, 1. to convert a substance into an oxide; combine with oxygen. 2. to undergo or cause to undergo oxidation; lose or remove electrons. Thus, oxidized.

**oxidized hemoglobin** *see* OXYHEMOGLOBIN.

**oxidized shale** *see* BURNT SHALE.

**oxidized zone** *Geology*, the part of an orebody or a mineral deposit in which the sulfides have been altered to carbonates and oxides by the action of surface waters bearing oxygen, soil acids, and carbon dioxide.

**oxidizer** *Chemistry*, an agent that oxidizes. *Space Technology*, specifically, a substance, usually containing oxygen, that supports the combustion reaction of a rocket fuel. Together, the fuel and oxidizer constitute a propellant. Also, OXIDANT.

**oxidizing agent** *Chemistry*, the species that gains electrons in an oxidation-reduction reaction and is itself reduced.

**oxidizing atmosphere** *Chemistry*, a space that is rich in oxygen, and where oxidation occurs.

**oxidizing flame** *Chemistry*, a gas flame in which the portion used contains excess oxygen.

**oxidoreducta** *see* REDUCTASE.

**oxidoreductase** *Enzymology*, a class of enzymes that catalyze the transfer of electrons from one substrate to another.

**oxime** *Organic Chemistry*,  $\text{CH}(\text{NOH})_2$  and aldehydes.

**oximeter** *Medicine*, a controlled space instrument used to measure the oxygen content of a fluid, such as blood.

**oximetry** *Medicine*, the measurement of oxygen content in blood.

**oxine** *Organic Chemistry*, a compound that is used in the synthesis of indole.

**oxirane** *see* EPoxide.

**oxisol** *Geology*, a type of soil, and is aluminum, kaol.

**oxisuran** *Onco*, a group of C=

**oxo-** *Organic Chemistry*, a group of C=

**oxoacid-lyase** *Enzymology*, the cleavage of oxoacids.

**oxodecenic acid** *Chemistry*, a type of acid which is used in the synthesis of polymers.

**oxoferrite** *Geology*, a type of oxide in solid solution.

**oxonium compound** *Chemistry*, a compound in which the oxygen atom has a positive charge.

**oxo process** *Chemistry*, a process for converting alkenes to ketones.

**oxy-** *Chemistry*, a combining element.

**oxycanthine** *Chemistry*, a compound derived from the chloroform.

**oxycetylene** *Chemistry*, a type of torch used for melting.

**oxycetylene torch** *Chemistry*, a type of torch used for melting.

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**plastic flow** *Physics*, a phenomenon in which solids may undergo a variety of extensive, irreversible deformations after the applied stress reaches a critical value.

**Plasticine** *Materials*, the trade name for a synthetic substitute for modeling clay.

**plastic instability** *Materials Science*, severe localization of the plastic deformation in materials under tensile stresses (necking); because of the decreased cross-sectional area, the true stress increases tend to fracture them.

**plasticity** *Mechanics*, the fact of being plastic; the property of a body by which it undergoes plastic deformation when the applied stress exceeds a certain value, known as the yield value.

**plasticity index** *Geology*, the range of water content at which a soil behaves plastically, equal to the percentage difference between the liquid limit and the plastic limit.

**plasticization** *Materials Science*, a process used to lower glass transition temperature; it improves the flexibility of certain polymers, allowing them to remain flexible well below the glass transition temperature of unplasticized materials.

**plasticize** *Engineering*, to make a material malleable by mixing it with a plasticizer, or by applying heat.

**plasticizer** *Engineering*, a material, usually organic, that is capable of imparting flexibility to nonplastic material or improving the flexibility of ceramic mixtures. *Materials Science*, see WATER REDUCER.

**plasticlast** *Geology*, an intraclast made up of calcareous mud that was fragmented while still soft.

**plastic limit** *Geology*, the minimum amount of water mixed with a given sediment or soil that enables the soil to be rolled into a thin thread, without breaking the thread.

**plasticorder** *Engineering*, an instrument that measures the temperature, viscosity, and shear-rate relationships of a plastic substance to determine its eventual behavior.

**plasticoviscosity** *Mechanics*, the property of a material whose rate of plastic deformation when subjected to stresses exceeding the yield stress is a linear function of the applied stresses.

**plastic paint** *Materials*, a thick-texture paint that can be worked to a patterned finish.

**plastic plate** *Electronics*, a collection of dielectric materials used as a base for a semiconductor device. *Graphic Arts*, 1. a direct offset-printing plate made on paper or other material coated with a thermoplastic vinyl resin; used for short, medium-quality press runs. 2. a molded printing plate made by pouring thermosetting plastic powder into a plastic mold; used for long press runs of type and simple line art.

**plastics** *Materials Science*, materials of high molecular weight that consist primarily of synthetic polymers or condensates, which can be shaped by flow into objects of diverse shapes and sizes.

**plastic strain** *Materials Science*, a permanent displacement of material, as in slip or twinning; the displacement remains after the stress has been removed.

**plastic surgeon** *Surgery*, a specialist in plastic surgery.

**plastic surgery** *Surgery*, a surgical procedure to repair, remodel, or restore defective or injured tissue or body parts or to improve their shape or appearance. Also, **plastic operation**.

**Plastic Wood** *Materials*, the trade name for a compound that is used to patch and fill woodwork.

**plastic wrap** *Materials*, a thin, transparent sheet of plastic that can cling to other substances; used to wrap and store food and for microwave cooking.

**plastic zone** *Geology*, in an explosion crater, a region bordering the rupture zone at an increased distance from the shock site, having less fracturing than and only small permanent deformations in comparison to the rupture zone. *Materials Science*, a heavily plastically deformed region in a material, generally adjacent to the tip of a crack that can cause crack-tip blunting.

**plastid** *Cell Biology*, any of a number of membrane-bound organelles found in plant cells and performing a specific function for the cell, such as a photosynthetic chloroplast.

**plastify** see PLASTICATE.

**plastisol** *Materials*, a dispersion of resin in a plasticizer that gels when heated.

**plastocyanin** *Biochemistry*, a blue, copper protein that transports electrons in chloroplast membranes from photosystem I to photosystem II during photosynthesis.

**plastogene** *Cell Biology*, a gene located in a plastid of a plant cell rather than in the nucleus.

**plastoglobuli** *Biochemistry*, a group of globules, found in plastids, that contain principally lipid.

**plastome** *Molecular Biology*, the genetic complement of a plastid.

**plastometer** *Engineering*, 1. an instrument used to measure the viscosity or flexibility of a material. 2. an instrument that measures the flow characteristics of a thermoplastic resin as it moves through an orifice at a certain pressure and temperature. 3. a machine for determining the stress and strain properties of metals at high temperatures and at various rates of strain.

**plastron** *Vertebrate Zoology*, the ventral portion of the shell of a turtle or tortoise, composed of four bony plates and covered with epidermal scales. *Invertebrate Zoology*, 1. in some adult aquatic insects, a thin layer of gases held in place by extremely fine, charged hairs on the body surface, to allow for respiration when the insect is submerged. 2. in heart urchins, a modified plate on the underside. 3. in spiders, a ventral plate on the cephalothorax.

**plat** *Cartography*, a plan drawn to scale that shows the boundaries and subdivisions of a piece of land, intended for use during development or sale of that land, and not necessarily showing other planimetric, relief, or cultural detail.

**Plata** see RIO DE PLATA.

**Platacidae** *Vertebrate Zoology*, an equivalent name for Ogcocephalidae, a family of marine fishes commonly known as batfishes.

**Platanaceae** *Botany*, a family of monoecious dicotyledonous trees in the order Hamamelidales, having simple deciduous leaves, large and conspicuous stipules, and small, densely clustered fruit.

**Platanistidae** *Vertebrate Zoology*, the freshwater or river dolphins, a family of toothed whales of the order Odontoceta, characterized by a long, slender rostrum, and a prominent bulge on the forehead; found in southern Asia and South America.

**Plataspidae** *Invertebrate Zoology*, shiny, oval, true bugs, a family of hemipteran insects in the superfamily Pentatomioidea.

**platband** *Architecture*, 1. a flat structural member, as a lintel or flat band. 2. a shallow molding having a flat face.

**plate** any of various thin, flat objects or devices, such as the large, circular dish on which food is served; specific uses include: *Metalurgy*, a thin, flat piece of metal, especially one used to provide support or protection of a surface, fitting, or joint. *Building Engineering*, a base member, as of a partition or other frame. *Anatomy*, a flat structure or layer, such as a thin layer of bone. *Medicine*, a hard fitting to which artificial teeth are attached. *Graphic Arts*, 1. also, **printing plate**, a surface that can be etched or engraved (by hand, mechanically, or photographically) and from which impressions onto another surface can be made for the purpose of printing. 2. also, **photographic plate**, a glass plate coated with photosensitive emulsion; an earlier form of photographic film, still used with nuclear emulsions to track charged particles. 3. an illustration in a book, especially a color illustration. *Electricity*, 1. the electrode in a cell, battery, or tube toward which current flows or to which electrons are attracted; an anode. 2. of or relating to an anode. Thus, **plate current**, **plate efficiency**, **plate modulation**, **plate neutralization**, **plate power**, **plate saturation**, and so on. *Horology*, the solid base onto which are mounted the wheels, pinions, springs, and screws that compose the movement of a timepiece. *Geology*, 1. one of several large, mobile blocks of continental or oceanic crust, together with some portion of the asthenosphere, that move as a single, nearly rigid unit. 2. a hard, smooth, thin, flat fragment of rock or stone, such as a flagstone.

**plate amalgamation** *Metalurgy*, a metallic plate used for amalgamating gold with mercury.

**plateau** plural, **plateaus** or **plateaux**, *Geology*, an extensive, nearly level land area, with at least one steep side, that is higher than the surrounding area and usually at least 2000 feet above sea level. *Electronics*, the point in a response curve where an increase in the independent variable no longer affects the dependent variables. (From the French word for "plate.")

**plateau basalt** *Geology*, a large, extensive basaltic lava flow or series of flows from fissure eruptions that accumulate to form a plateau. Also, **FLOOD BASALT**.

**plateau characteristic** *Electronics*, a relationship between two variables in which the dependent variable reaches a value that does not change with further increase of the independent variable.

**plateau glacier** *Hydrology*, a glacier formed on a mountain plateau, usually overflowing the edges in hanging glaciers.

**plateau gravel** *Geology*, a sheet or patch of surficial gravel on a plateau or other region above the height at which stream-terrace gravel is usually found

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**van der Waals covolume** *Physical Chemistry*, the constant in the van der Waals equation that corrects for the nonnegligible size of the molecules.

**van der Waals equation** *Physical Chemistry*, an equation of state that describes the behavior of real or nonideal gases by using two corrective terms that take into account the size of the molecules and the forces between them: the term representing the repulsive forces is satisfactory only in the limit of low densities and overestimates their effect at high densities; the term representing the attractive forces is well founded in theory.

**van der Waals force(s)** *Physical Chemistry*, a general term for those forces of attraction between atoms or molecules that are not the result of chemical bond formation or simple ionic attraction; i.e., the relatively brief and weak interactions that neutral, chemically saturated molecules experience, such as dipole-dipole forces. Also, VAN DER WAALS ATTRACTION, VAN DER WAALS-LONDON INTERACTION(S).

**van der Waals-London interaction(s)** see VAN DER WAALS FORCE(S).

**van der Waals surface tension formula** *Thermodynamics*, a relationship between the surface tension of a liquid  $g$  and the temperature  $T$ :  $g = K p_c^{2/3} T_c^{1/3} (1 - T/T_c)^n$  where  $K$  is a constant,  $p_c$  is the critical pressure,  $T_c$  is the critical temperature, and  $n$  is approximately 1.23.

**Van Dorn sampler** *Engineering*, a sediment sampler that has a plexiglass cylinder sealed at each end with rubber force cups.

**vandyke** see BROWNLINE.

**vandyke brown** see BLACK EARTH.

**vane** *Mechanical Engineering*, a flat or curved surface that moves when exposed to a flow of fluid and rechannels the flow. *Aviation*, any of a wide variety of thin, relatively flat objects designed to align with an airflow; used, for example, to direct airflow, to detect airflow and communicate with a control system, to provide stability for an aircraft, or to direct the flow in an engine, pump, or compressor. *Navigation*, 1, a long, narrow piece of cloth that indicates the direction of the wind; on smaller vessels it is usually attached to the top of the masthead, while on larger vessels it is often mounted on the side of the ship. 2, on an azimuth circle or pelorus, a sight that is used to observe the bearing.

**Vane, John Robert** born 1927, English pharmacologist; shared the Nobel Prize for work in prostaglandins.

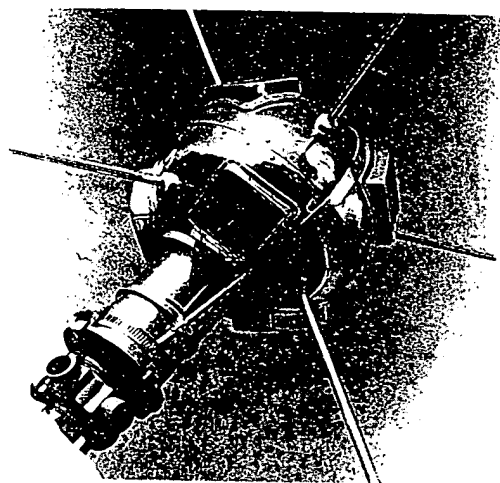
**vane anemometer** *Engineering*, a portable instrument, in which a number of vanes radiate from a shared shaft, which rotates when facing the wind; used to measure low air and wind speeds in large ducts.

**vane-anode magnetron** *Electronics*, a magnetron containing plane-parallel walls between adjacent cavities.

**vane-type instrument** *Engineering*, an instrument in which the pointer is moved by either the force of repulsion between fixed and moveable magnetized vanes or the force between a coil and a pivoted vane-shaped piece of soft iron.

**Vaneyellidae** *Invertebrate Zoology*, a family of sea cucumbers, holothurian echinoderms in the order Dactylochirotida, with fingerlike tentacles.

**Vanguard** *Space Technology*, any of a series of three geodesical satellites launched by the United States in 1958 and 1959 as a part of the International Geophysical Year program.



Vanguard

**van Helmont, Johann Baptista** 1579–1644, Belgian alchemist; coined the term *gas*; isolated oxides from air; proposed pathogenic theory of disease.

**vanilla** *Botany*, a tropical orchid of the genus *Vanilla*, especially *Vanilla planifolia*, that bears a podlike fruit. *Food Technology*, 1, the fruit of this plant. Also, **vanilla bean**, 2, an extract made with dried, fermented vanilla beans; used in flavoring foods and in perfumes. *Computer Programming*, 1, relating to a computer system that is very general in its application or relatively uncomplicated. 2, a version of a computer system or program prior to enhancements or upgrades.

**vanillin** *Organic Chemistry*,  $C_8H_8O_3$ , sweet-smelling, white crystalline needles; somewhat soluble in water and alcohol; melts at 81–83°C; used in perfumes, flavorings, pharmaceuticals, as a reagent, and as a source of L-dopa. Also, **vanillic aldehyde**.

**vanish** *Mathematics*, a function or operator that equals zero at some point of its domain is said to vanish at that point.

**vanishing line** *Photogrammetry*, the unique straight line on an aerial photograph that contains all the vanishing points of all the systems of parallel lines that are parallel to a single plane.

**vanishing point** *Mathematics*, in a perspectivity, a point at which the lines joining corresponding points intersect. *Photogrammetry*, the point in the plane of a photograph at which a system of parallel lines in the object space converge.

**vanishing tide** *Oceanography*, a tide in which the water level remains at a stand for several hours instead of rising or falling continuously in the normal pattern, so that the tide seems to disappear.

**vannus** *Entomology*, the fanlike posterior or anal lobe of an insect's wing, differentiated from the rest of the wing by a furrow.

**vanoxite** *Mineralogy*, a rare, weakly radioactive, inadequately described, black mineral with an approximate formula of  $V_4^{+4}V_2^{+5}O_{13} \cdot 8H_2O$ , occurring as microscopic crystals and in massive form; found replacing wood and cementine sandstone in the Colorado plateau area.

**van pool** *Transportation Engineering*, a work-oriented ride-sharing service, often using a company van and an employee as a regular driver.

**V antenna** *Electromagnetism*, a directional antenna having a pair of radiating elements forming a V and fed at the apex.

**van't Hoff, Jacobus** [van täf'] 1852–1911, Dutch chemist; developed the theory of stereochemistry; awarded the Nobel Prize for laws of dilute solutions and chemical thermodynamics.

**van't Hoff equation** *Physical Chemistry*, an equation that accounts for the effect of temperature on the equilibrium constant in a gaseous reaction when pressure remains constant. Also, **van't Hoff isochore**.

**van't Hoff factor** *Physics*, the proportionality constant that appears between the observed osmotic pressure and the pressure predicted by ideal conditions; given by the osmotic pressure divided by the quantity of the gas constant times the temperature divided by the volume.

**van't Hoff formula** *Organic Chemistry*, the formula of calculation stating that the number of stereoisomers of a sugar molecule is equal to  $2^n$ , with  $n$  equal to the number of asymmetric carbon atoms.

**van't Hoff isotherm** *Physical Chemistry*, an equation that shows the change in free energy during a chemical reaction.

**vanthoffite** *Mineralogy*,  $Na_6Mg(SO_4)_4$ , a colorless monoclinic mineral occurring in massive form, having a specific gravity of 2.694 and a hardness of 3.5 on the Mohs scale; found in oceanic salt deposits.

**van't Hoff's law** *Physics*, a law stating that a dissolved substance exerts the same osmotic pressure as it would if it were an ideal gas that occupied the same volume as the container.

**Van Vleck, John H.** 1899–1980, American physicist; worked in magnetism; awarded the Nobel Prize for his research on electron correlation.

**Van Vleck equation** *Quantum Mechanics*, an equation giving the paramagnetism of a magnetically susceptible substance.

**Van Vleck paramagnetism** *Quantum Mechanics*, the paramagnetism of a collection of ions, atoms, or molecules as predicted by quantum theory.

**vapor** *Physical Chemistry*, a gas whose temperature is less than the critical temperature, so that it may be liquefied or solidified by compression at constant temperature; i.e., a dispersion in air of molecules of a substance that is a liquid or a solid in its normal state, such as water vapor.

**vapor-compression cycle** *Mechanical Engineering*, a complete cooling cycle in which the refrigerant is first made to boil, producing a cooling effect, and then recompressed into its liquid state.

**vapor concentration** see ABSOLUTE HUMIDITY.

**vapor cycle** *Thermodynamics*, a thermodynamic cycle that operates on a substance that is at all times in its vapor phase, or at least passes through the vapor phase during a portion of the cycle.

**water-tube boiler** *Mechanical Engineering*. 1. a boiler in which water is contained in a series or sections of tubes. 2. a steam boiler in which a number of closely spaced water-cooling tubes are connected to drums that act as water pockets and steam separators, an arrangement yielding rapid water circulation and quick steaming. Also, INTEGRAL-FURNACE BOILER.

**water tunnel** *Aviation*. an open-throated or closed-throated chamber or apparatus designed for aerodynamic testing, similar to a wind tunnel but using water instead of air as its working fluid.

**water type** *Oceanography*. seawater of a particular temperature and salinity.

**water vapor** *Physical Chemistry*. water that is in its gaseous state, especially when it is in this gaseous state below the boiling point of water. *Meteorology*. atmospheric water in vapor form; one of the most important of all components of the atmosphere, serving as the raw material for clouds and rain, as a vehicle for energy transport, and as a regulator of planetary temperatures via the greenhouse effect. Also, AQUEOUS VAPOR.

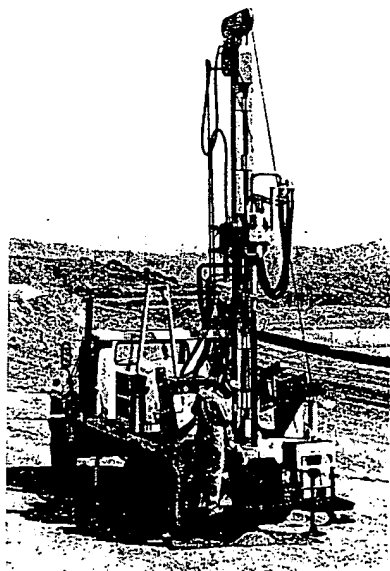
**water-vapor laser** *Optics*. a laser in which a water-vapor substance produces a beam of infrared radiation at specific wavelengths.

**waterwall** *Mechanical Engineering*. a water-cooling system used in boilers, in which a network of tubes carrying circulating water forms or lines one wall of the boiler.

**waterway** *Navigation*. 1. a navigable channel, especially a dredged channel. 2. a channel formed along the outboard edge of a weather deck which leads water to the scuppers.

**water well** *Civil Engineering*. any well from which groundwater is drawn. Depending on the depth of the water table, such wells may be dug, driven by means of a pointed pipe, bored by means of an auger, or drilled by means of a water-well drill.

**water-well drill** *Civil Engineering*. a specialized power-drilling apparatus used to tap very deep groundwater reservoirs.



water-well drill

**water-wettable** *Chemistry*. of a substance, able to absorb or adsorb water.

**waterwheel** *Mechanical Engineering*. a wheel arranged with floats or buckets so that it can be turned by flowing water; used as a source of energy to drive machinery or raise water.

**water white** *Chemistry*. a standard of color for liquids with the appearance of clear water.

**waterworks** *Civil Engineering*. 1. a municipal or regional water distribution plant, typically consisting of a pumping station and purification facilities. 2. an entire public water supply system, including reservoirs, pipelines, and other facilities.

**water year** *Hydrology*. any twelve-month period used as a basis for hydrologic data; in the United States, the period beginning October 1 and ending September 30.

**water yield** *Hydrology*. the amount of runoff from a drainage basin, equal to the amount of precipitation minus the amount lost by evapotranspiration. Also, RUNOFF.

**WATS** [wäts] *Telecommunications*. a telephone service that allows a subscriber to direct-dial an unlimited number of calls to one or more of six regions in the continental United States for a flat monthly charge. (An acronym for wide-area telephone service.)

**Watson, James Dewey** born 1928, American biochemist; with Crick, discovered the double helix and constructed the Watson-Crick model.

**Watson, John Broadus** 1878–1958, American psychologist; founder of the behaviorist school of psychology.

**Watson-Crick model** *Molecular Biology*. the double-helical molecular structure of DNA propounded by James D. Watson and Francis Crick.

**Watson equation** *Physical Chemistry*. an empirical equation that is used to calculate heat of vaporization data for organic compounds to within 10–15°C of their critical temperature.

**Watson-Sommerfeld transformation** *Mathematics*. a device for converting a series whose  $k$ th term is the product of the  $k$ th Legendre polynomial and a coefficient  $a_k$  into the sum of a contour integral of  $a(k)$  and terms involving the poles of  $a(k)$ , where  $a(k)$  is a meromorphic function such that  $a(k) = a_k$  at integer values of  $k$ .

**Watson-Watt, Sir Robert** 1892–1973, Scottish electrical engineer; developed radar.

**Watt, James** 1736–1819, Scottish engineer and inventor; invented the condenser and the first practical steam engine.

**watt** *Physics*. a unit of power in the SI or MKS system of units, equivalent to one joule per second; in electrical power it is equal to the current in amperes multiplied by the electrical potential in volts. (Named for James Watt.)

**Watt's law** *Thermodynamics*. a law stating that the sum of the latent heat of vaporization of a sample of water at any temperature  $T$  and the heat transfer required to raise the same amount of water from 0°C to  $T$  is constant.

**wattage** *Electricity*. the power output or consumption of an electrical device, expressed in watts.

**wattage rating** *Electricity*. 1. the recommended output power of an electronic device. 2. the recommended power dissipation of an electronic device.

**watt current** see ACTIVE CURRENT.

**wattevillite** *Mineralogy*. a white, silky, orthorhombic or monoclinic mineral, with the approximate formula  $\text{Na}_2\text{Ca}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$ , occurring as aggregates of minute, hairlike or acicular, water-soluble crystals with a sweetish to astringent taste, having a specific gravity of 1.81 and an undetermined hardness; found in pyrite-rich lignite near Bischofsheim, Germany.

**watt-hour** *Electricity*. the practical unit of energy, equal to the power of 1 watt absorbed continuously for 1 hour.

**watt-hour capacity** *Electricity*. the number of watt-hours a storage battery can deliver safely under specific operating conditions including temperature, pressure, and other parameters.

**watt-hour meter** *Electrical Engineering*. an integrating meter that measures the total electric energy consumed in a circuit over time.

**wattle** *Building Engineering*. an interlacing of twigs or tree branches used for fence, wall, roof, or framing construction. *Vertebrate Zoology*. a flap or fold of flesh that hangs down from the throat of certain animals, such as the turkey.

**wattle-and-daub** *Archaeology*. denoting a type of construction in which a framework of flexible wooden sticks (wattle) is coated with mud (daub).

**wattless current** see REACTIVE CURRENT.

**wattless power** see REACTIVE POWER.

**wattmeter** *Engineering*. an instrument that measures electric power in terms of watts.

**watt-second** *Physics*. a unit of energy equivalent to one joule.

**wave** *Physics*. a uniformly advancing disturbance in a medium, in which the moved parts undergo a double oscillation; a collective disturbance that propagates at a definite speed. Also, WAVE MOTION. *Fluid Mechanics*. any disturbance or sudden change in conditions that moves through a flow. *Oceanography*. such a disturbance occurring on the surface of the sea or other body of water, taking the form of a moving swell or ridge of water. *Military Science*. a formation of forces, landing ships, craft, amphibious vehicles, or aircraft that is required to beach or land at approximately the same time; it may be classified according to type, function, or landing order as follows: assault wave, boat wave, helicopter wave, numbered wave, on-call wave, or scheduled wave.



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KIRK-OTHMER

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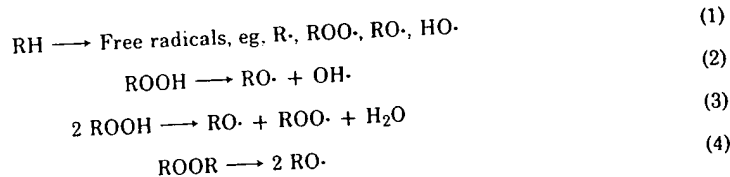
## ANTIOXIDANTS

Antioxidants are used to retard the reaction of organic materials with atmospheric oxygen. Such reaction can cause degradation of the mechanical, aesthetic, and electrical properties of polymers; loss of flavor and development of rancidity in foods; and an increase in the viscosity, acidity, and formation of insolubles in lubricants. The need for antioxidants depends upon the chemical composition of the substrate and the conditions of exposure. Relatively high concentrations of antioxidants are used to stabilize polymers such as natural rubber and polyunsaturated oils. Saturated polymers have greater oxidative stability and require relatively low concentrations of stabilizers. Specialized antioxidants which have been commercialized meet the needs of the industry by extending the useful lives of the many substrates produced under anticipated conditions of exposure. The sales of antioxidants in the United States were approximately \$730 million in 1990 (1,2).

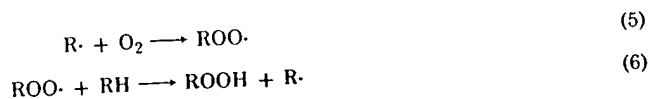
### Mechanism of Uninhibited Autoxidation

The mechanism by which an organic material (RH) undergoes autoxidation involves a free-radical chain reaction (3-5):

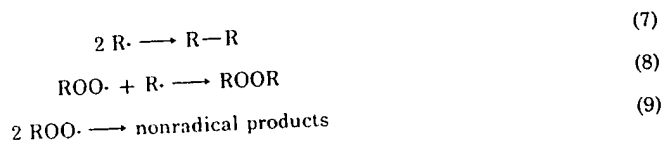
#### Initiation



#### Propagation



#### Termination



**Initiation.** Free-radical initiators are produced by several processes. The high temperatures and shearing stresses required for compounding, extrusion, and molding of polymeric materials can produce alkyl radicals by homolytic chain cleavage. Oxidatively sensitive substrates can react directly with oxygen, particularly at elevated temperatures, to yield radicals.

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190. A. Martin, *J. Brit. Interplanetary Soc. Suppl.* **SI-S192** (1978).

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**PLASTIC BUILDING PRODUCTS.** See BUILDING MATERIALS, PLASTIC.

## PLASTICIZERS

A plasticizer is a substance the addition of which to another material makes that material softer and more flexible. This broad definition encompasses the use of water to plasticize clay for the production of pottery, and oils to plasticize pitch for caulking boats. A more precise definition of plasticizers is that they are materials which, when added to a polymer, cause an increase in the flexibility and workability, brought about by a decrease in the glass-transition temperature,  $T_g$ , of the polymer. The most widely plasticized polymer is poly(vinyl chloride) (PVC) due to its excellent plasticizer compatibility characteristics, and the development of plasticizers closely follows the development of this commodity polymer. However, plasticizers have also been used and remain in use with other polymer types.

The amount of plasticizer added to the polymer in question varies, depending on the magnitude of the effect required. For example, a small addition of plasticizer may be made simply to improve the workability of the polymer melt. This contrasts with larger additions made with the specific intention of completely transforming the properties of the product. For example, PVC without a plasticizer, ie, unplasticized PVC (PVC-U), is used in applications such as pipes and window profiles; with plasticizer added, articles such as PVC food film, PVC cable insulation, and sheathing and PVC floorings are formed.

There are presently ~300 plasticizers in manufacture. Of these ~100 are of commercial importance. A list of some common commodity and speciality plasticizers are given in Table 1.

### Types of Plasticizers

Two principle methods exist for softening a polymer to bring about the dramatic effects of plasticization. A rigid polymer may be internally plasticized by chemically modifying the polymer or monomer so that the flexibility of the

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73. *Reduction of Fire Hazard Using Fire Retardant Chemicals*, Fire Retardant Chemicals Association, Lancaster, Pa., 1989.
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## PHOSPHORUS FLAME RETARDANTS

One of the principal classes of flame retardants used in plastics and textiles is that of phosphorus, phosphorus-nitrogen, and phosphorus-halogen compounds (see also FLAME RETARDANTS FOR TEXTILES). Detailed reviews of phosphorus flame retardants have been published (1-6) (see also PHOSPHORUS COMPOUNDS).

### Mechanisms of Action

**Condensed-Phas Mechanisms.** The mode of action of phosphorus-based flame retardants in cellulosic systems is probably best understood. Cellulose (qv) decomposes by a noncatalyzed route to tarry depolymerization products, notably levoglucosan, which then decomposes to volatile combustible fragments such as alcohols, aldehydes (qv), ketones (qv), and hydrocarbons (qv) (7-9). However,

when catalyzed by acids, the decomposition of cellulose proceeds primarily as an endothermic dehydration of the carbohydrate to water vapor and char. Phosphoric acid is particularly efficacious in this catalytic role because of its low volatility (see PHOSPHORIC ACID AND THE PHOSPHATES). Also, when strongly heated, phosphoric acid yields polyphosphoric acid which is even more effective in catalyzing the cellulose dehydration reaction. The flame-retardant action is believed to proceed by way of initial phosphorylation of the cellulose. Certain nitrogen compounds such as melamines, guanidines, and ureas appear to catalyze the cellulose phosphorylation step and are found to enhance or synergize the flame-retardant action of phosphorus on cellulose (10-13). The nonvolatile phosphorus acids are also able to coat the char, rendering the char less permeable and protecting it from further oxidation. The retention of phosphorus in the char may be aided by the nitrogen synergists.

In poly(ethylene terephthalate) (14-16) and poly(methyl methacrylate) (17-19), the mechanism of action of phosphorus flame retardants is at least partly attributable to a decrease in the amount of combustible volatiles and a corresponding increase in nonvolatile residue (char). In poly(methyl methacrylate), the phosphorus flame retardant appears to cause an initial cross-linking through anhydride linkages (19).

The amount and physical character of the char from rigid urethane foams is found to be affected by the retardant (20-23) (see FOAMS; URETHANE POLYMERS). The presence of a phosphorus-containing flame retardant causes a rigid urethane foam to form a more coherent char, possibly serving as a physical barrier to the combustion process. There is evidence that a substantial fraction of the phosphorus may be retained in the char. Chars from phenolic resins (qv) were shown to be much better barriers to pyrolysis vapors and air when ammonium phosphate was present in the original resin (24). This barrier action may at least partly explain the inhibition of glowing combustion of char by phosphorus compounds.

In polymers such as polystyrene that do not readily undergo charring, phosphorus-based flame retardants tend to be less effective, and such polymers are often flame retarded by antimony-halogen combinations (see STYRENE POLYMERS). However, even in such noncharring polymers, phosphorus additives exhibit some activity that suggests at least one other mode of action. Phosphorus compounds may produce a barrier layer of polyphosphoric acid on the burning polymer (4,5). Phosphorus-based flame retardants are more effective in styrenic polymers blended with a char-forming polymer such as a polyphenylene oxide or polycarbonate.

Phosphorus-containing additives can act in some cases by catalyzing thermal breakdown of the polymer melt, reducing viscosity and favoring the flow or drip of molten polymer from the combustion zone (25). On the other hand, red phosphorus [7723-14-0] has been shown to retard the nonoxidative pyrolysis of polyethylene (a radical scission). For that reason, the scavenging of radicals in the condensed phase has been proposed as one of several modes of action of red phosphorus (26).

Several commercial polyester fabrics are flame retarded using low levels of phosphorus additives that cause them to melt and drip more readily than fabrics without the flame retardant. This mechanism can be completely defeated by the presence of nonthermoplastic component such as infusible fibers, pigments, or by

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# **VAN NOSTRAND'S SCIENTIFIC ENCYCLOPEDIA**

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Underwater flame cutting is possible at depths of 135 feet (40.5 ) or more using special practice.

**E HARDENING.** Surface hardening of steel or cast iron by a thin surface layer to the hardening temperature with an oxyne flame, followed by rapid cooling. Depending on the nature part to be hardened, either the torch system or the work itself moved. Cylindrical parts are rotated before a stationary flame. jet or liquid spray following the torch is used to quench-harden ace. The relatively cool metal in the interior hastens cooling of ace by conduction. The depth of flame hardening may be less inch to about  $\frac{1}{4}$  inch (1.6–6 millimeters), depending on the thick- the section and the service requirements. Distortion is generally n in parts hardened by general heating and quenching.

no hardening agent such as carbon or nitrogen is added to the of the steel by this process, only steels having sufficient carbon n readily upon quenching are used for flame hardening. The sirable range is 0.35–0.70% carbon. The hardening treatment ed by a low-temperature tempering treatment to relieve quench- ns. Typical applications of flame hardening are gear teeth, cams, surfaces, rail ends, crankshafts, and many other machine parts s.

**PHOTOMETRY AND SPECTROMETRY.** The basic prin- flame emission spectrometry rests on the fact that salts of metals, roduced under carefully controlled conditions into a suitable e vaporized and excited to emit radiations that are characteristic element. Correlation of the emission intensity with the concen- that element forms the basis of quantitative evaluation.

terminations of sodium and potassium constitute the majority hed applications. However, the flame is a suitable emission r at least 45 elements, which may be grouped as follows:

*elements determined:* aluminum, barium, boron, calcium, cesium, r, copper, iron, lead, lithium, magnesium, manganese, potas- idium, sodium, strontium.

*elements determined but sometimes overlooked:* antimony, arsenic, cadmium, cobalt, gallium, indium, lanthanum, nickel, palla- : earths (except cerium), rhodium, ruthenium, scandium, silver, thallium, tin, and yttrium.

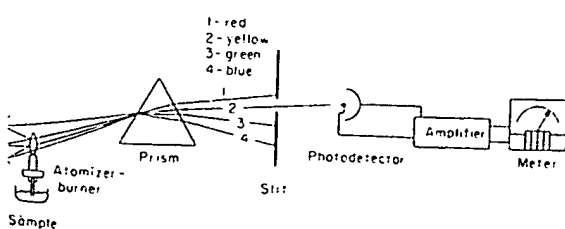
*elements with distinctive but less sensitive flame spectra:* beryl- nium, gold, mercury, molybdenum, niobium, rhenium, sele- con, titanium, tungsten.

*elements determined by indirect means:* bromine, chlorine, fluo- ie (although bromine, chlorine and fluorine can be determined etallic halide spectra), phosphorus, and silicon.

ls in which these elements are determined by flame spec- cclude water, glasses, cement, soils, fertilizers, plant materials, fluids and tissues, petroleum products and metallurgical prod-

ne spectrometer, used in emission spectrometry, consists of ssure regulators and flow meters for the fuel gases; (2) the device; (3) the flame source; (4) the optical system; (5) appo- nsensitive detectors; and (6) the electrical circuit for measuring g the intensity of the radiation. Depending upon the use he instrument may be a relatively simple assemblage of inter- ers and a photo-detector, i.e., a flame photometer, or it may rate prism or grating monochromator, i.e., a flame spectrom- the instrument illustrated.

all flame spectrometers rely on atomization to deliver a of solution to the flame. The solution is drawn through a sitioned either concentric with or at right angles to the annulus



Flame spectrometer.

or capillary from which the aspirating gas (oxygen or air under pressure) enters. At the tip of the solution capillary, the liquid is sheared off and dispersed into droplets by the blast of oxygen or air.

The best isolation of radiant energy can be achieved with flame spec- trometers that incorporate either a prism or grating monochromator, those with prisms having variable gauged entrance and exit slits. Both these spectrometers provide a continuous selection of wavelengths with resolving power sufficient to separate completely most of the easily excited emission lines, and afford freedom from scattered radiation suffi- cient to minimize interferences. Fused silica or quartz optical components are necessary to permit measurements in the ultraviolet portion of the spectrum below 350 nanometers. See also **Analysis (Chemical); Atomic Spectroscopy; Photometers; and Spectro Instruments.**

**FLAME-RETARDING AGENTS.** A material used as a coating on or a component of a combustible product to raise its ignition point. The protection provided is usually only partial, and most materials so treated will burn when exposed to sufficiently high temperatures. The three principal types of agents are: (1) *nondurable*, consisting of water- soluble inorganic salts, which are easily removed by washing or accidental exposure to water; (2) *semi-durable* (removed by repeated laundering or dry-cleaning); and (3) *durable* (not affected by laundering or dry-cleaning). The latter types include or have included in the past organic compounds of bromine and chlorine, and insoluble metal salts. Antimony trioxide, tricresyl phosphate and other phosphate esters, chlorendic acid, etc., are effective, as well as cellulose-reactive agents. Zinc carbonate in high volume concentration will render a rubber or plastic compound self-extinguishing.

In 1972, flammability standards for children's sleepwear were estab- lished in the United States. In an effort to confer flame-resistant properties to the fabrics used, manufacturers began to use a number of chemical additives, notably organic halogens or phosphate esters, or both. One of the most widely used was *tris*-(2,3-dibromopropyl)phosphate, com- monly called tris-BP. Other closely associated compounds were used. At a considerably later date, some researchers found that tris-BP and related compounds were carcinogenic, among other negative qualities. There is much room for further research into finding effective flame retardants that do not have adverse side effects.

**FLAMINGO** (*Aves, Phoenicopteriformes*). Large wading birds of several species found in the warm regions of the world with the exception of Australia. They have very long legs and neck and a broad beak bent sharply downward at the middle. Red or rosy shades are characteristic in their plumage. Some authorities regard the flamingo as related ances- trally to ducks, geese, and swans. Only in comparatively recent years has the flamingo been placed in its own class, the *Phoenicopteriformes*. Flamingos are considered among the most beautiful of all birds—grace- ful, friendly, but gregarious. They range in length up to 6½ feet (2 meters) and may be as much as 5 feet (1.5 meters) in height. Although these birds essentially are mute, they do make a chattering noise with their beak, which at times can become quite loud. In flight, the neck stretches forward and the legs slant backward to aid in their streamlining. Like some other water birds, the flamingo has a filtering mechanism as part of its bill. The bill is boxlike and can be used in the manner of a scoop. Nests are constructed of dirt and mud in the form of mounds from 12 to 16 inches (30–41 centimeters) in diameter. One or two chalk-white eggs are incubated by both parents. They require from 30 to 32 days to hatch. The chick is downy and able to run around almost immediately after hatching. When sleeping, the flamingo rests on one foot, drawing the other up into the feathers, with the knuckle part sticking out far behind. The flamingo is found from the Bahamas to South Amer- ica and the Galapagos Islands. Some domesticated flocks are found in Florida. The birds also are found in the high Andes and in parts of France and Spain. The birds often fly in formation. See also **Phoenicop- teri.**

**FLANGE.** A rim or projection extending completely around the object which is flanged. Thus, a flange is distinguished from an ear, which is a similar projection, but which extends only a small portion of the circumference. Flanges are employed for a great many different purposes, among which is the juncture of adjacent shafts by flanged couplings, the flanges providing a means of alignment and support.